PATENT ABSTRACTS OF JAPAN

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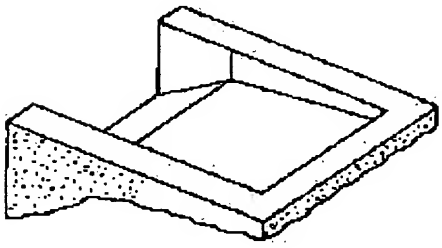
(54) PRODUCTION OF CASTING MOLD FOR CASTING HIGH MELTING ACTIVE METAL



(57)Abstract:
PURPOSE: To cast a product having small surface roughness and a shallow reaction cured layer by coating the casting mold with CaO and/or Y2O2 having average grain sizes of specific values at a.thickness of a specific value by a plasma spraying method.
CONSTITUTION: The inside surface of the casting mold in contact with the molten metal is coated with the CaO and/or Y2O3 having 10 to 40μm average grain sizes at 100 to 300μm thickness by the plasma spraying method. Longer time is needed before the prescribed thickness is attained if the anerage grain size is smaller khan 10μm, and the strength of the spraying layer decrease if the average grain size is larger than 40μm. The coating of the inside surface with W and/or Mo by plasma spraying is equally well. As a result, the inside surface of the casting mold in contact with a molten high melting active metal is coated by thermal spraying with the material having extremely little reaction with the high melting active metal, and therefore the cast product having the shallow reaction cured layer of the casting surface is produced.

CLAIMS

[Claim(s)]
[Claim 1] the mold inside which touches molten metal -- CaO with a mean particle diameter of 10-40 micrometers Y2O3 [and/or,] -- a plasma metal spray method -- thickness 100-300 The manufacture approach of the mold for high-melting active metal casting characterized by covering to mum.
[Claim 2] To the mold inside which touches molten metal, it is thickness with a plasma metal spray method about W and/or Mo with a mean particle diameter of 10-40 micrometers. 100-300 The manufacture approach of the mold for high-melting active metal casting characterized by covering to mum.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the manufacture approach of the mold for precision casting of high-melting active metals, such as Ti or Ti alloy.
[0002]
[Description of the Prior Art] As the manufacture approach of the mold for precision casting of high-melting active metals, such as Ti or Ti alloy Add a binder to the powder (filler) of the matter which cannot produce said molten metal and reaction easily, and a slurry is adjusted. Or sprinkle the grain (stucco) of the quality of the material of a different class, and the 1st layer (face coat) is formed. or [that it is the same after covering this on the front face of a cast and a low isomorphism-like mold] -- Subsequently, after forming a backup layer in the slurry and stucco which consist of the quality of the material of of the same kind or a different class, a delow and ROSUTO wax casting to calcinate are adopted. in this case -- as the filler used for a face coat -- ** -- refractory metals, such as W and Mo, and ** -- ZrO2, **CaO, Y2O3, or a rare-earth-elements oxide is used.
[0003] Moreover, the approach of applying said slurry to the mold inside produced by the ceramic mold methods, such as a Shaw process or a unicast process, is also used. In any case, since casting metals are high-melting and activity, the dissolution and casting in a vacuum are indispensable, and in order to suppress generating of the gas at the time of teeming, it is necessary to fully calcinate casting beforehand at an elevated temperature 1000 degrees C or more.
[0004]
[Problem(s) to be Solved by the Invention] By the way, as means forming of the mold tapetum (face coat) which touches molten metal as mentioned above, when a slurry was used, there were the following troubles. In using refractory metals, such as W and Mo, as a filler of a slurry, in order that these metal powder may oxidize at the time of mold molding and baking, it is necessary to use reducing furnaces, such as a hydrogen ambient atmosphere furnace, for mold baking, and baking effectiveness is bad, and danger is high.
[0005] Moreover, when using CaO, Y2O3, or a rare-earth-elements oxide as a filler of a slurry, it is unstable in respect of aging of a slurry, and the duration of service of a slurry and the storage approach of mold have a limit. Furthermore, although the handling of a slurry and the manufactured mold was easy when using ZrO2 as a filler

of a slurry, the reaction with a molten metal metal needed to be large, and it needed to use for manufacture of the cast of thin meat extremely, or the chemical milling after casting etc. needed to remove the reaction hardening layer.
[0006] In view of the above situations, a different means from the method of applying a slurry is used for this invention as the formation approach of a face coat, it wipes away the various troubles accompanying the slurry applying method, and aims at the surface roughness of a cast being small and offering the manufacture approach of the mold for high-melting active metal casting which enables casting of the comparatively shallow product of a reaction hardening layer.
[0007]
[Means for Solving the Problem] In order to solve the above trouble, as a result of inquiring wholeheartedly, this invention persons propose covering of the mold inside by the plasma metal spray as means forming of a face coat. namely, the mold inside to which this invention touches molten metal -- CaO with a mean particle diameter of 10-40 micrometers Y2O3 [and/or,] -- a plasma metal spray method -- thickness 100-300 It is the manufacture approach of the mold for high-melting active metal casting characterized by covering to mum. Moreover, to the mold inside which touches molten metal, it is thickness 100-300 with a plasma metal spray method about W and/or Mo with a mean particle diameter of 10-40 micrometers. It is the manufacture approach of the mold for high-melting active metal casting characterized by covering to mum.
[0008]
[Function] In this invention, models, such as a low mold which has the dimension which added the elongation cost which seasoned the cast as a product with the solidification shrinkage of molten metal etc., or a pattern, are produced, and a face coat ingredient is covered with thermal spraying to the inside of the mold molded and calcinated by the lost wax process or the ceramic mold method based on these each. In the case of the divided mold, finally mold is combined, and casting is presented.
[0009] The thermal spray material of this invention is CaO. And/or, if smaller than the mean particle diameter of 10 micrometers, by the time the case where they are Y2O3 or W, and/or Mo will become predetermined thickness, time amount will be taken, and it is not industrially suitable. On the other hand, if it becomes larger than 40 micrometers, the granularity of a thermal-spraying layer front face will become large, and the reinforcement of a thermal-spraying layer not only falls, but it will spoil the smooth nature on the front face of a cast.
[0010] Moreover, the enveloping layer of the thermal spray material of this invention is CaO. And/or, when the case of Y2O3 or W, and/or Mo was thinner than 100 micrometer and a high-melting active metal molten metal is cast, a reaction with this cannot fully be prevented but a reaction hardening layer is produced on a cast front face. On the other hand If thicker than 300 micrometers, the difference of the thickness by the location of a thermal-spraying layer will become large, and will check the dimensional accuracy as a precision casting article.
[0011] Moreover, since flame spraying of the mold inside which touches the high-melting active metal molten metal of this invention is carried out by the high-melting active metal and the matter with very few reactions, it can obtain a cast with a shallow reaction hardening layer on a cast front face.
[0012]
[Example]
One top view of the low mold with which example 1 drawing 1 (a) was divided into two, and (b) are the side elevation. According to the conventional method of a lost

wax process, it molded using the slurry and stucco which are shown in Table 1 in this low mold, and the piece of mold shown in <A HREF="/Tokujitu/tjitemdrw.ipdl?N0000=239&N0500=1 E_N/;?9>;=7==///&N0001=929&N0552=9&N0553=000007" TARGET="tjitemdrw"> drawing 2 was obtained. In addition, the drying time between the 1st layer and the 2nd layer made the drying time between other layers 3 hours or more for 8 hours. It dried after coating termination of the last layer for 24 hours, and calcinated at 1000 degrees C after the delow by the autoclave for 2 hours.

[0013]

[Table 1]

層	スラリー		スタッコ
	バインダー	フィラー	
1	SiO_2ゾル	ジルコン粉末	ジルコンサンド
2～6	SiO_2ゾル	ジルコン粉末	シャモットサンド
7	SiO_2ゾル	ジルコン粉末	シャモットサンド

[0014] The plasma metal spray of the thermal spray material shown in Table 2 was carried out to this piece of mold. And the trial mold which pastes up two mold pieces created on the same conditions, and is shown in drawing 3 was produced. Next, the Ti-6%aluminum-4%V alloy was dissolved using electron beam melting and a casting furnace, and teeming was carried out to the above-mentioned trial mold in the vacuum.

[0015] Mold was completely removed after cooling, the surface roughness of the cast cast and the hardening layer depth were measured, and the propriety as a precision casting article was judged. A result is shown in Table 2. The criterion was decided as follows.

O It has quality sufficient as a :Ti alloy precision casting article.

**: As a Ti alloy precision casting article, quality is a little inferior.

[0016]

[Table 2]

No	溶射条件			鋳造品の状況		判定
	溶射材料	粒径（μm）	厚み（μm）	表面粗さ（μm）	反応層深さ（μm）	
1	Y_2O_3	5 *	50 *	35	300	△
2	Y_2O_3	10	50 *	40	300	△
3	Y_2O_3	10	100	15	100	○
4	Y_2O_3	20	50 *	40	300	△
5	Y_2O_3	20	100	15	100	○
6	Y_2O_3	20	200	10	100	○
7	Y_2O_3	20	300	15	100	○
8	Y_2O_3	40	200	15	100	○
9	Y_2O_3	75 *	400 *	50	50	△
10	CaO	25	50 *	40	300	△
11	CaO	25	100	15	200	○
12	CaO	25	200	10	100	○
13	Mo	5 *	50 *	35	300	△
14	Mo	10 *	50 *	35	300	△
15	Mo	20 *	50 *	40	300	△
16	Mo	20	100	20	100	○
17	Mo	20	200	15	100	○
18	Mo	20	300	15	100	○
19	Mo	40	200	20	100	○
20	Mo	80 *	400 *	30	100	△
21	W	30	100	15	200	○
22	W	30	200	15	200	○
23	W	30	400 *	20	200	△

＊ ： 本発明の範囲外

[0017] The piece of mold shown in drawing 2 by the completely same approach as example 2 example 1 was produced, and the plasma metal spray was given according to the thermal spray material and spray condition which are shown in Table 3. Plasma metal spray conditions are the same as an example 1. And the trial mold which pastes up two mold pieces which carried out the plasma metal spray on the same conditions, and is shown in drawing 3 was produced.

[0018] Next, the Ti-6%aluminum-4%V alloy was dissolved using electron beam melting and a casting furnace, and teeming was carried out to the above-mentioned trial mold in the vacuum. Mold was completely removed after cooling, the surface roughness of the cast cast and the hardening layer depth were measured, and the propriety as a precision casting article was judged. A result is shown in Table 3. In

addition, the criterion is the same as an example 1.
[0019]
[Table 3]

No	溶射材料と溶射条件	鋳造品の状況		判定
		表面粗さ（μm）	反応層深さ（μm）	
24	Y_2O_3を厚さ50μm溶射後、CaO を厚さ50μm溶射。	15	100	○
25	CaO を厚さ50μm溶射後、Y_2O_3を厚さ50μm溶射。	15	100	○
26	$Y_2O_3$50重量部とCaO50 重量部の混合粉を厚さ100 μmに溶射。	15	100	○
27	Moを厚さ50μm溶射後、Wを厚さ50μm溶射。	20	100	○
28	Wを厚さ50μm溶射後、Moを厚さ50μm溶射。	20	100	○
29	Moを50重量部と50W重量部の混合粉を厚さ100 μmに溶射。	20	100	○

＊ ： 本発明の範囲外

[0020]
[Effect of the Invention] In order that unlike slurry spreading the mold made by the manufacture approach of this invention may be stable in respect of aging and may form a face coat after mold baking, it does not oxidize W and Mo too much. Furthermore, the front face was smooth and it made it possible to cast a product with a comparatively shallow reaction hardening layer.

TECHNICAL FIELD

[Industrial Application] This invention relates to the manufacture approach of the mold for precision casting of high-melting active metals, such as Ti or Ti alloy.

PRIOR ART

[Description of the Prior Art] As the manufacture approach of the mold for precision casting of high-melting active metals, such as Ti or Ti alloy Add a binder to the powder (filler) of the matter which cannot produce said molten metal and reaction easily, and a slurry is adjusted. Or sprinkle the grain (stucco) of the quality of the material of a different class, and the 1st layer (face coat) is formed. or [that it is the same after covering this on the front face of a cast and a low isomorphism-like mold] -- Subsequently, after forming a backup layer in the slurry and stucco which consist of the quality of the material of of the same kind or a different class, a delow and ROSUTO wax casting to calcinate are adopted. in this case -- as the filler used for a face coat -- ** -- refractory metals, such as W and Mo, and ** -- ZrO2, **CaO, Y2O3, or a rare-earth-elements oxide is used.
[0003] Moreover, the approach of applying said slurry to the mold inside produced by the ceramic mold methods, such as a Shaw process or a unicast process, is also used. In any case, since casting metals are high-melting and activity, the dissolution and

casting in a vacuum are indispensable, and in order to suppress generating of the gas at the time of teeming, it is necessary to fully calcinate casting beforehand at an elevated temperature 1000 degrees C or more.

EFFECT OF THE INVENTION

[Effect of the Invention] In order that unlike slurry spreading the mold made by the manufacture approach of this invention may be stable in respect of aging and may form a face coat after mold baking, it does not oxidize W and Mo too much. Furthermore, the front face was smooth and it made it possible to cast a product with a comparatively shallow reaction hardening layer.

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] By the way, as means forming of the mold tapetum (face coat) which touches molten metal as mentioned above, when a slurry was used, there were the following troubles. In using refractory metals, such as W and Mo, as a filler of a slurry, in order that these metal powder may oxidize at the time of mold molding and baking, it is necessary to use reducing furnaces, such as a hydrogen ambient atmosphere furnace, for mold baking, and baking effectiveness is bad, and danger is high.

[0005] Moreover, when using CaO, Y2O3, or a rare-earth-elements oxide as a filler of a slurry, it is unstable in respect of aging of a slurry, and the duration of service of a slurry and the storage approach of mold have a limit. Furthermore, although the handling of a slurry and the manufactured mold was easy when using ZrO2 as a filler of a slurry, the reaction with a molten metal metal needed to be large, and it needed to use for manufacture of the cast of thin meat extremely, or the chemical milling after casting etc. needed to remove the reaction hardening layer.

[0006] In view of the above situations, a different means from the method of applying a slurry is used for this invention as the formation approach of a face coat, it wipes away the various troubles accompanying the slurry applying method, and aims at the surface roughness of a cast being small and offering the manufacture approach of the mold for high-melting active metal casting which enables casting of the comparatively shallow product of a reaction hardening layer.

MEANS

[Means for Solving the Problem] In order to solve the above trouble, as a result of inquiring wholeheartedly, this invention persons propose covering of the mold inside by the plasma metal spray as means forming of a face coat. namely, the mold inside to which this invention touches molten metal -- CaO with a mean particle diameter of 10-40 micrometers Y2O3 [and/or,] -- a plasma metal spray method -- thickness 100-300 It is the manufacture approach of the mold for high-melting active metal casting characterized by covering to mum. Moreover, to the mold inside which touches molten metal, it is thickness 100-300 with a plasma metal spray method about W and/or Mo with a mean particle diameter of 10-40 micrometers. It is the manufacture

approach of the mold for high-melting active metal casting characterized by covering to mum.

OPERATION

[Function] In this invention, models, such as a low mold which has the dimension which added the elongation cost which seasoned the cast as a product with the solidification shrinkage of molten metal etc., or a pattern, are produced, and a face coat ingredient is covered with thermal spraying to the inside of the mold molded and calcinated by the lost wax process or the ceramic mold method based on these each. In the case of the divided mold, finally mold is combined, and casting is presented.
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EXAMPLE

[Example]
One top view of the low mold with which example 1 drawing 1 (a) was divided into two, and (b) are the side elevation. According to the conventional method of a lost wax process, it molded using the slurry and stucco which are shown in Table 1 in this low mold, and the piece of mold shown in drawing 2 was obtained. In addition, the drying time between the 1st layer and the 2nd layer made the drying time between other layers 3 hours or more for 8 hours. It dried after coating termination of the last layer for 24 hours, and calcinated at 1000 degrees C after the delow by the autoclave for 2 hours.
[0013]
[Table 1]

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7	SiO_2ゾル	ジルコン粉末	シャモットサンド

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[0015] Mold was completely removed after cooling, the surface roughness of the cast cast and the hardening layer depth were measured, and the propriety as a precision casting article was judged. A result is shown in Table 2. The criterion was decided as follows.
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[0016]
[Table 2]

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6	Y_2O_3	20	200	10	100	○
7	Y_2O_3	20	300	15	100	○
8	Y_2O_3	40	200	15	100	○
9	Y_2O_3	75 *	400 *	50	50	△
10	CaO	25	50 *	40	300	△
11	CaO	25	100	15	200	○
12	CaO	25	200	10	100	○
13	Mo	5 *	50 *	35	300	△
14	Mo	10 *	50 *	35	300	△
15	Mo	20 *	50 *	40	300	△
16	Mo	20	100	20	100	○
17	Mo	20	200	15	100	○
18	Mo	20	300	15	100	○
19	Mo	40	200	20	100	○
20	Mo	80 *	400 *	30	100	△
21	W	30	100	15	200	○
22	W	30	200	15	200	○
23	W	30	400 *	20	200	△

＊ ： 本発明の範囲外

[0017] The piece of mold shown in drawing 2 by the completely same approach as

example 2 example 1 was produced, and the plasma metal spray was given according to the thermal spray material and spray condition which are shown in Table 3. Plasma metal spray conditions are the same as an example 1. And the trial mold which pastes up two mold pieces which carried out the plasma metal spray on the same conditions, and is shown in drawing 3 was produced.

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[0019]

[Table 3]

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25	CaO を厚さ50μm溶射後、Y_2O_3を厚さ50μm溶射。	15	100	○
26	$Y_2O_3$50重量部とCaO50 重量部の混合粉を厚さ100 μmに溶射。	15	100	○
27	Moを厚さ50μm溶射後、Wを厚さ50μm溶射。	20	100	○
28	Wを厚さ50μm溶射後、Moを厚さ50μm溶射。	20	100	○
29	Moを50重量部と50W重量部の混合粉を厚さ100 μmに溶射。	20	100	○

＊ ： 本発明の範囲外

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is the (a) top view of a low mold and the (b) side elevation which were divided into two.

[Drawing 2] It is the perspective view of the method of one of the piece of mold divided into two.

[Drawing 3] It is the perspective view of mold.